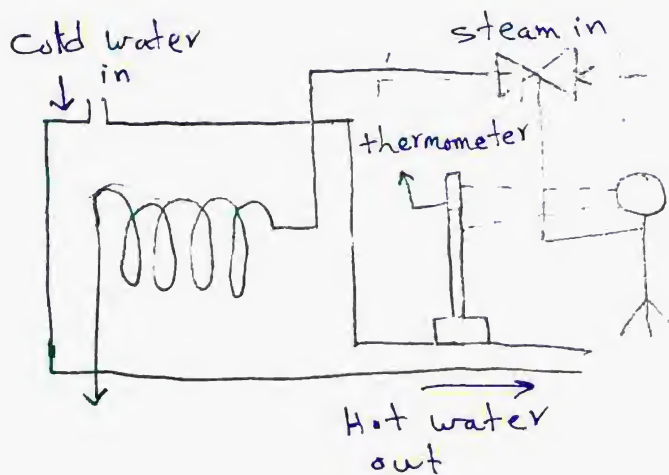Industrial Control

(النظري)
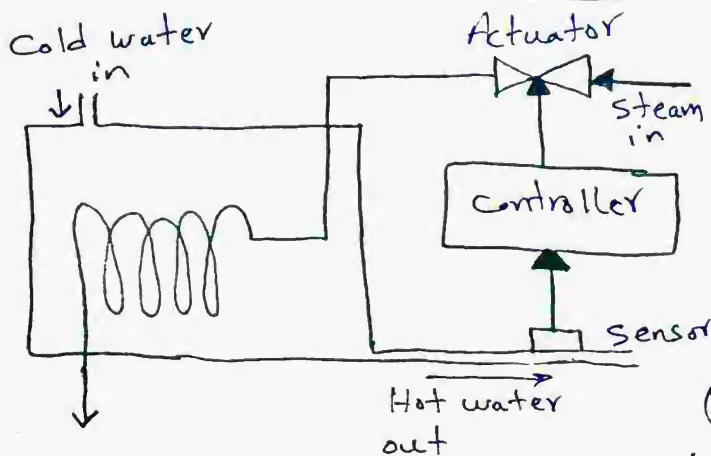
until midterm.

Process Control

Definition ✏

↳ automatic control of an output variable by sensing the amplitude of output Parameter from the process & comparing it to desired or set level and feeding error signal back to control an input variable.
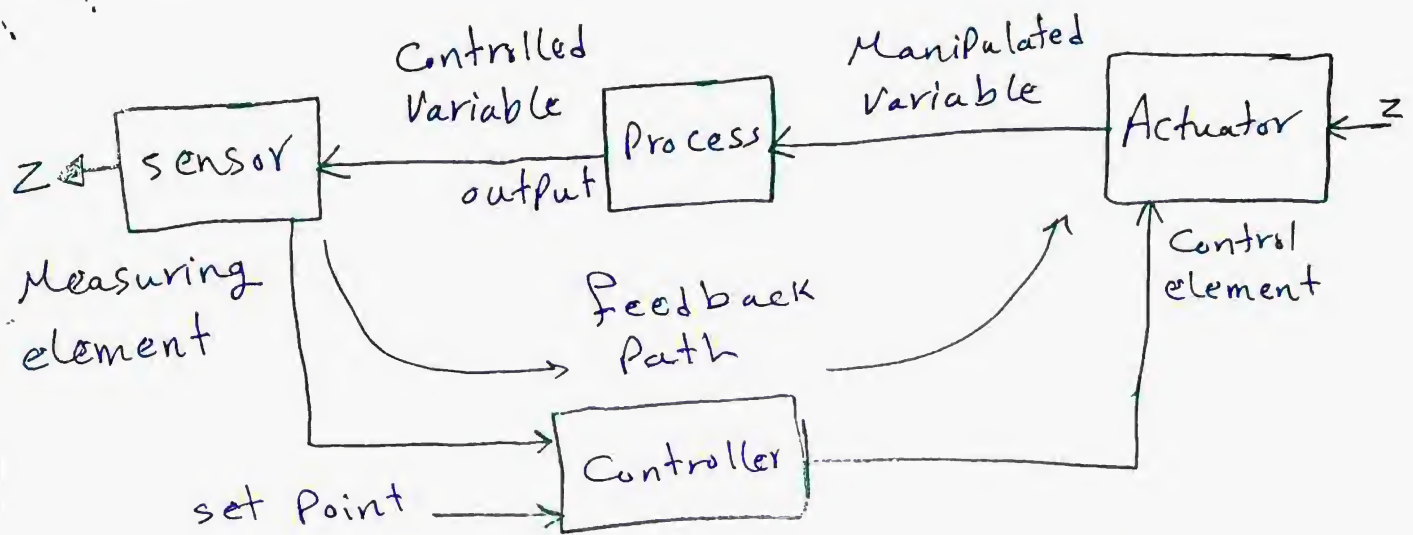

→ two graphs show manual & automatic control ✓

Cold water in ↓

steam in ⋈

thermometer

Hot water out →

Manual control

Cold water in ↓

Actuator ⋈

Steam in

Controller

Sensor

Hot water out →

ـما الـ (Sensor) هو يحس (sense)
للمياه الخارجة (حرارتها) زادت أو قلت)
لو حدث تغيير في الحرارة هيبعت
الـ (Controller) (~~signa~~)
والـ بدوره هيبعت الـ (actuator)
الـ ضيظبط الـ (steam flow)
عشان نحصل على درجة الحرارة المطلوبة.

[1]

Controlled Variable — output

Manipulated Variable

Z → sensor

Process

Actuator ← Z

Measuring element

feedback Path

Control element

set Point → Controller

"Block diagram of Process control loop"

---

* Controlled Variable vs Manipulated variable

1) Controlled (measured) variable
  ↳ the monitored output variable from a Process.
  ↳ The value of monitored output Parameter is normally held within tight given limits.

2) Manipulated variable.
  ↳ the input variable or Parameter that is varied by a control signal from Processor to an actuator.
  ↳ by changing the input variable the value of the measured variable can be Controlled.

* Set Point

L→ the desired value of the output parameter or variable being monitored by a sensor.

L→ Any deviation from this value will generate an error signal.

* Feedback loop :-

L→ signal path from output back to the input to correct for any variation between the output level from set level.

* Transducers

L→ devices that can change one form of energy to another.

[ex] resistance thermometer converts temperature into electrical resistance.

* Converters

L→ devices used to change format of signal without changing energy form.

* Actuator

L→ devices that are used to control an input variable in response to a signal from controller.

* Controllers

↳ devices that monitor signals from transducers
and take necessary action to keep Process within
specified limits.

* PLC (Programmable logic Controllers)

↳ used in Process-Control applications.

↳ have the ability to use (analog or digital)
input info. and output signals.

↳ can communicate other Controllers globally.

* error signal /

↳ difference between set point and amplitude
of measured variable

* Correction signal:

↳ signal used to control power to actuator
to set the level of input variable.

* Transmitters

↳ devices used to amplify and format signals
to be suitable for ~~transmission~~ transmission over
long distances with minimal loss of
information.

Smart Sensors

*Sensor

↳ element that Produces signal relating to the quantity to be measured.

↳ devices that can detect Physical variables such that temperature or motion

*Smart sensor

↳ It is the intelligent sensor.

↳ which is termed from combining electrical output (Produced from sensor) with some interfacing hardwares.

* Sensors + "   "   = Smart Sensors.

Applications

* General applications:-
1) self calibration   2) Communication   3)
3) Computation.   4) Multi sensing.
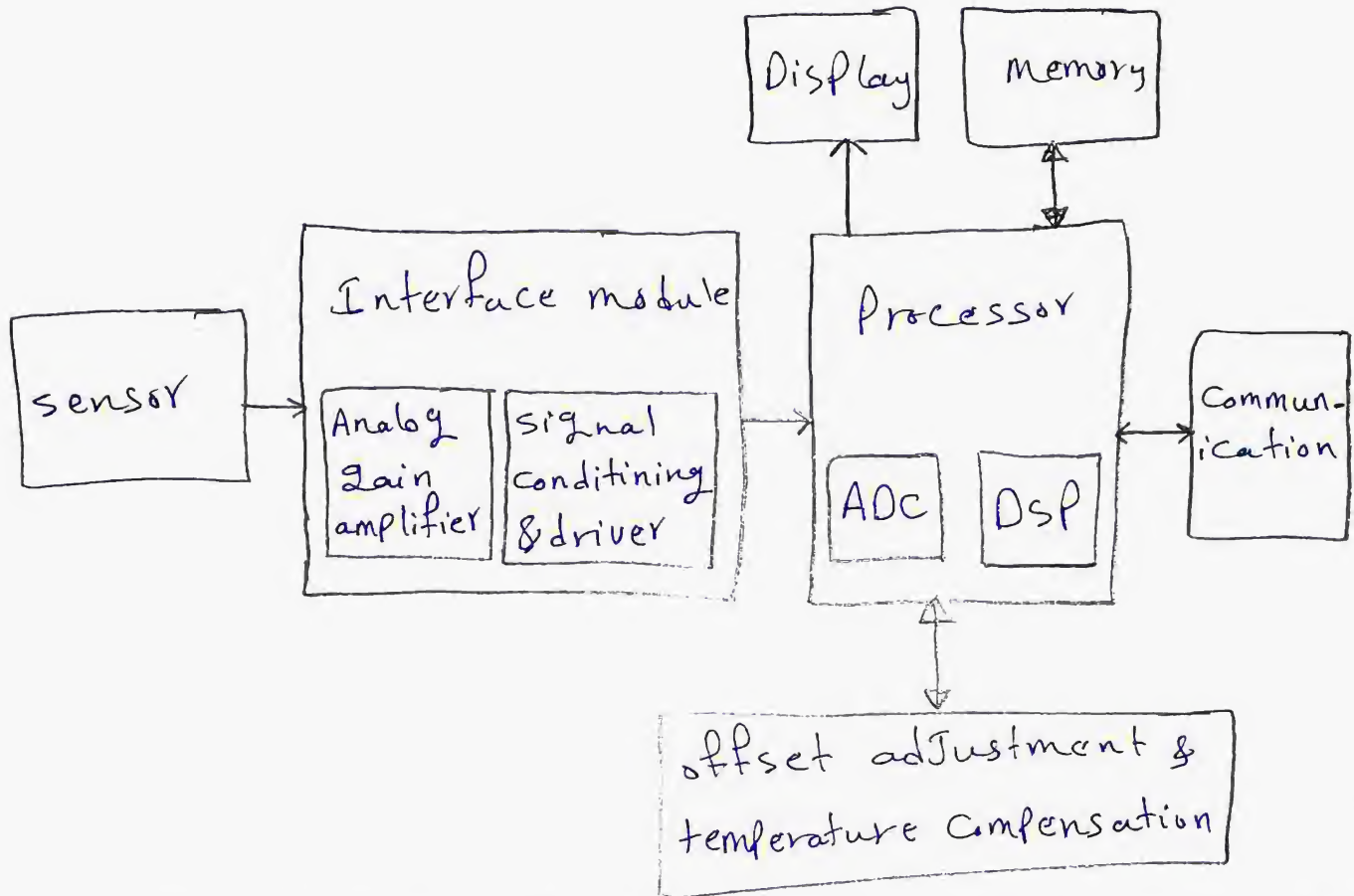
* Industrial applications:-
1) optical Sensor.   2) Infra red detector.
3) structural monitoring.   4) gelogical mapping

*Medical apps:
1) Food safety   2) Health monitoring.   3) Medical diagnostics.

# * Block diagram of smart sensor :-

```
                        ┌─────────┐  ┌─────────┐
                        │ Display │  │ Memory  │
                        └─────────┘  └─────────┘
                             ↑            ↕
  ┌────────┐   ┌─────────────────────┐  ┌──────────────────┐   ┌──────────┐
  │        │   │ Interface module    │  │ Processor        │   │ Commun-  │
  │ sensor │──→│ ┌───────┐ ┌───────┐ │─→│                  │←→ │ ication  │
  │        │   │ │Analog │ │Signal │ │  │ ┌─────┐  ┌─────┐  │   │          │
  └────────┘   │ │gain   │ │condit-│ │  │ │ ADC │  │ DSP │  │   └──────────┘
               │ │ampli- │ │ining  │ │  │ └─────┘  └─────┘  │
               │ │fier   │ │&driver│ │  └──────────────────┘
               │ └───────┘ └───────┘ │          ↕
               └─────────────────────┘  ┌──────────────────────┐
                                        │ offset adjustment &   │
                                        │ temperature compensation │
                                        └──────────────────────┘
```

* Multiplexer (Mux)

↳ device that selects one of several analog
or digital input signals and forward the
selected input into single line.

↳ A Mux of 2^n inputs,
has n select lines,
which are used to select
which input line to
send to output.

inputs $\frac{2^N}{}$ → Mux → $\frac{1}{}$ output

↓ N
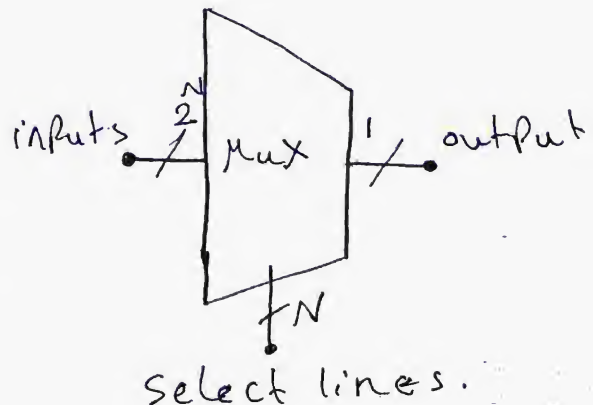
select lines.

*Demutiplexer

↳ device that produces
multiple number of outputs
from a single input.

↳ A demux with single input
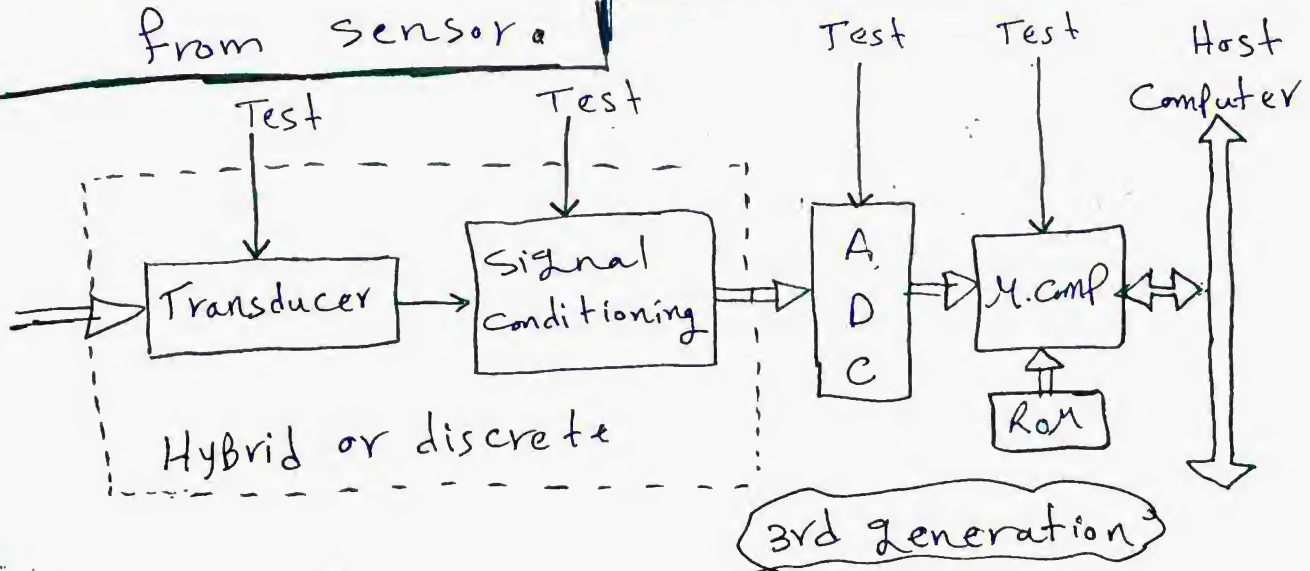an 2^n outputs has $2n$ select
lines.

input 1 → | Demux | 2^N → outputs

N ↓ select lines.
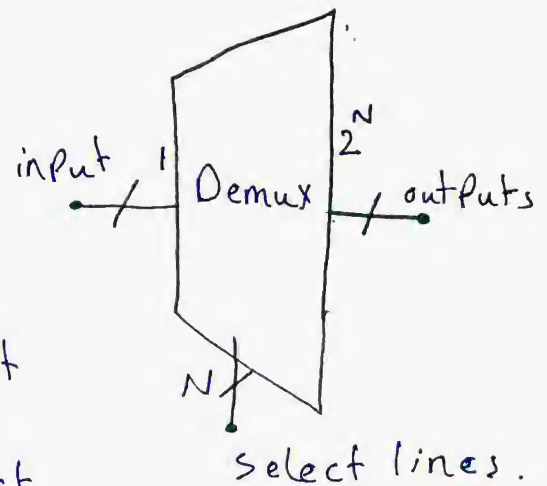
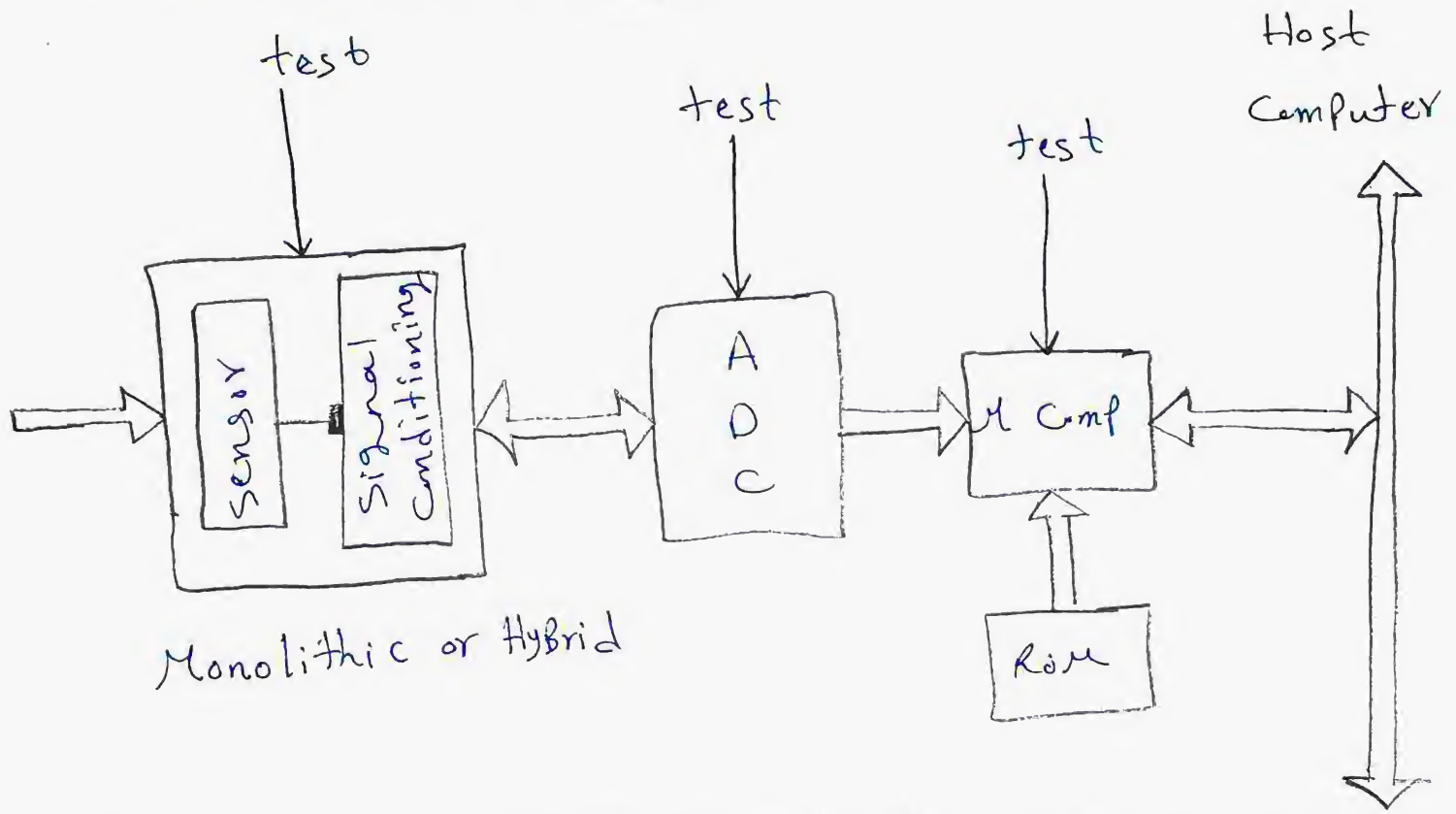## Evolution of smart sensors

*1st generation:
↳ Its devices had little, if any electronics
associated with ~~them~~ them.

*2nd generation sensors
↳ were part of purely analog systems
with virtually all of electronics remote
from sensor.

Test → Transducer → Signal Conditioning → A.D.C → M.cmp ↔ Host Computer

ROM

Hybrid or discrete

3rd generation

Fourth generation

test

Sensor | Signal Conditioning

Monolithic or Hybrid

test

A
D
C

test

µ Comp

RoM

Host Computer

Fifth generation

integrated sensor | A D C

Monolithic

Functionality tested unit →

test

µ ComP

PRoM | RoM

Host Computer